# MUSIC OF THE MOONS.

By PLINY EARLE CHASE, LL. D.

A recent note from Professor Hall, the discoverer of the satellites of Mars, contains the following query:

"Will the inner moon of Mars fall into harmony, or will it make a discord?"

If we start from a point near the theoretical beginning of nebular condensation for the outer satellite,[i] and take $2 \times 3 - 1$ harmonic divisors, of the form $\text{div.}_{n+1} = 3\ \text{div.}_n - \text{div.}_1 = \text{div.}_n + 3^{n-1}$, we find the following accordances:

| Numerator. | Divisors. | Quotients. | Observed. |
|---|---|---|---|
| 13·7 | $d_1 = 1$ | 13·700 | 13·692 = Nebular radius. |
| $d_2 = 3\,d_1 - d_1 =$ | 2 | 6·850 | 6·846 = Deimus.[ii] |
| $d_3 = 3\,d_2 - d_1 =$ | 5 | 2·740 | 2·730 = Phobus.[ii] |
| $d_4 = 3\,d_3 - d_1 =$ | 14 | ·979 | 1·000 = ♂ semi-diam. |
| $d_5 = 3\,d_4 - d_1 =$ | 41 | ·334 | ·333 = ♂ c. of rad. osc. |

In a letter to the editors of the *American Journal of Science and Arts* (Oct., 1877, p. 327), Professor Kirkwood calls attention to the rapid motion of the inner satellite, and asks: "How is this remarkable fact to be reconciled with the cosmogony of Laplace?" He suggests a partial explanation, based upon the motions of Saturn's ring, and concludes with the remark: "Unless some such explanation as this can be given, the short period of the inner satellite will doubtless be regarded as a conclusive argument against the nebular hypothesis."

This is undoubtedly true, if we accept the nebular hypothesis in the form in which it is popularly taught, and in which Laplace is commonly supposed to have held it. But there are probably very few among the students who have given the subject much careful attention, who have supposed that all the planet-building has taken place at the "limit of possible atmosphere," or the point of equal centripetal and centrifugal force. It may well be doubted whether the illustrious French astronomer ever held such an opinion, and it is certain

[i] *Phil. Mag.*, Oct., 1877, p. 292.

[ii] These are the names proposed for the satellites by their discoverer. Prof. Asaph Hall.

that Sir William Herschel never did, for he speculated on the "gradual subsidence and condensation" of nebulous matter "by the effect of its own gravity, into more or less regular spherical or spheroidal forms, denser (as they must in that case be) towards the centre."[i]

As necessary consequences of such subsidence, there would be an acceleration of velocity in all the nebular particles, the acceleration being more rapid in the nucleus, than near the outer surface of the nebula. Many indications point to the simultaneous, or nearly simultaneous, initiation of numerous planetary centres, and it is very doubtful if either of the two-planet belts, except, perhaps, that of Neptune and Uranus, will be long regarded as having been "thrown off" by the mere increase of centrifugal velocity.

At the very outset of my own investigations,[ii] I was careful to limit my acceptance of the nebular hypothesis to the qualified exposition of the Herschels. "Neither is there any variety of aspect which nebulæ offer, which stands at all in contradiction to this view. Even though we should feel ourselves compelled to reject the idea of a gaseous or vaporous 'nebulous matter,' it loses little or none of its force. Subsidence, and the central aggregation consequent on subsidence, may go on quite as well among a multitude of discrete bodies, under the influence of mutual attraction, and feeble or partially opposing projectile motions, as among the particles of a gaseous fluid."[iii]

It matters not whether there is such a thing as a luminiferous æther, or whether the hypothesis of such an entity is merely a convenient assumption for the co-ordination of results which are due to the action of forces *such as would exist* in such a medium. The proper study of the forces, and of their mathematical consequences, is the great thing to be sought, and the numerous accordances which I have already found, show how prolific such studies may become. Those accordances, as it seems to me, are already sufficient to establish the Herschelian hypothesis as a true theory, beyond the reach of all possible controversy. That the elastic, or quasi-elastic, forces, which are continually operating throughout the solar system, should extend the harmonic laws to the satellites, as well as to the planets

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[i] Herschel's "Outlines of Astronomy," § 871.

[ii] *Phil. Mag.*, April, 1876.

[iii] *Loc. cit.*

and to the spectral lines, is a necessary consequence of the simplicity and unity of design which underlie the manifold phenomena of the universe.

In the case of our own moon, as we have only two terms, Earth's semi-diameter and Moon's orbital major-axis, the harmonic equation is indeterminate; its direct solution is, therefore, impossible. I have elsewhere, however, called attention to the fact that Earth is central, in the belt which is bounded by the secular perihelion of Mercury and the secular aphelion of Mars, and this fact, together with the nearly synchronous rotation of all the planets in the belt, may be regarded as indications of common forces, such as would be likely to lead to common harmonies. The sixth and seventh divisors of the Mars series represent, respectively, the ratio of Earth's semi-diameter to Moon's major-axis, and the ratio of Earth's axial rotation to its orbital revolution, viz.:

$d_6 = 3\ d_5 - d_1 = 122.$ $\quad$ $120{\cdot}5331 =$ Moon's major-axis.
$d_7 = 3\ d_6 - d_1 = 365.$ $\quad$ $365{\cdot}2564 =$ Earth's year.

The satellite-systems of Jupiter, Saturn, and Uranus, all present unmistakable evidences of harmonic influences, some of which I propose to embody in a future article. Meanwhile, some of the readers of the JOURNAL may, perhaps, like the entertainment of trying to study them out by themselves.

HAVERFORD COLLEGE, *Oct. 17th*, 1877.

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**Jablochkoff Light.**—In the second trial at the West India docks in London, a very large court was first lighted by four electric candles, softened by ground glass, so that the eye could read small characters at a great distance, without being dazzled or fatigued. The exterior and interior of many buildings on the wharves were then successfully illuminated. The light of each candle was equivalent to 100 gas-burners. The carbons which were enclosed between the porcelain plates worked easily, and the light was not of a very long duration.—*Les Mondes.* C.

**New Vulcanizing Method.**—MM. Turpin Frères have received a platinum medal from the Société d'Encouragement, for new applications of caoutchouc and gutta-percha, the hardening being effected by magnesia.—*Les Mondes.* C.